UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/749,610	12/31/2003	Darvin R. Edwards	TI-36608 (032350.B566)	8535

23494 7590 12/07/2004

TEXAS INSTRUMENTS INCORPORATED
P O BOX 655474, M/S 3999
DALLAS, TX 75265

EXAMINER	
HO, TU TU V	

ART UNIT	PAPER NUMBER
2818	

DATE MAILED: 12/07/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/749,610	EDWARDS, DARVIN R.	
	Examiner	Art Unit	
	Tu-Tu Ho	2818	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *31 December 2003 and 08 November 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *15-23 and 25-35* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *15-23 and 25-35* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *31 December 2003* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Oath/Declaration

1. The oath/declaration filed on 12/31/2003 is acceptable.

Election/ Restriction

2. Applicant's election without traverse of Invention I, claims 15-23, cancellation claims 1-14 and 24, and addition of claims 25-35, in the reply filed on 11/08/2004 are acknowledged. Accordingly, **claims 15-23 and 25-35** are under examination.

Drawings

3. The drawings are objected to under 37 CFR 1.83(a). The drawings must show every feature of the invention specified in the claims. Therefore, the "the at least two dies operable to fit inside the at least one cavity when the lid is coupled to the substrate" of **claim 22** must be shown or the feature(s) canceled from the claim(s). No new matter should be entered.

Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as "amended." If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the

drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. The replacement sheet(s) should be labeled "Replacement Sheet" in the page header (as per 37 CFR 1.84(c)) so as not to obstruct any portion of the drawing figures. If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Claim Objections

4. Claim 32 is objected to because of the following informalities: the claim contains typographical error "the heat conductivity of the material is a thermoplastic material". The phrase should be "the heat conducting element is a thermoplastic material".

Claim Rejections - 35 USC § 112

The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter that the applicant regards as his invention.

5. **Claims 25-35** are rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one

skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

Claim 25 recites: "a heat conducting element having a thermal conductivity greater than 10 W/m-°C **adhering** to the inner surface of the cavity and conforming to the surface contour of the top surface of the chip and **contacting without adhering** to the top surface of the chip" (emphasis added) and **claim 35** recites: "a means for conducting heat from the die to the lid having a thermal conductivity greater than 10 W/m-°C, the heat conducting means **adhering** to the inner surface of the cavity and conforming to the surface contour of the top surface of the chip and **contacting without adhering** to the top surface of the chip" (emphasis added).

However, it is not clear from the specification how the heat conducting element or the heat conducting means, whether formed of a solder material or a thermally conductive epoxy, would adhere to the lid (adhere to the inner surface of the cavity of the lid) and would contacting without adhering to the top surface of the chip. Specifically, the specification fails to explain why after the steps 110, 120, 130, 140, and 150 ("apply conductive layer", "mount lid", "heat assembly", "cool assembly", and "remove lid"), without further disclosure such as material characteristics or treatment or intermediate layers, the heat conducting element, which is always in between and in direct contact with the lid and the chip in steps 130 and 140, would adhere to the lid and would contact without adhering to the chip.

Claims 26-34 depend from rejected claim 25 and include all limitations of claim 25 therefore are rejected for the same reason.

6. **Claims 25-35** are rejected under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 25 recites: "a heat conducting element having a thermal conductivity greater than 10 W/m-°C **adhering** to the inner surface of the cavity and conforming to the surface contour of the top surface of the chip and **contacting without adhering** to the top surface of the chip" (emphasis added) and **claim 35** recites: "a means for conducting heat from the die to the lid having a thermal conductivity greater than 10 W/m-°C, the heat conducting means **adhering** to the inner surface of the cavity and conforming to the surface contour of the top surface of the chip and **contacting without adhering** to the top surface of the chip" (emphasis added).

As noted above in paragraph numbered 5, Applicant fails to particularly point out the mechanism by which the limitations "adhering" and "contacting without adhering" arrive, thereby rendering the limitations indefinite. **For examination purpose**, the following variations are treated: (1) a heat conductive element formed of a solder material or a thermally conductive epoxy – rather than a traditional thermal paste which would adhere to the top surface of the chip – , the solder material or the epoxy might adhere to the lid and not to the chip and would meet the claimed properties; (2) a heat conductive element formed of a solder material or a thermally conductive epoxy, where the heat conductive element contacts – through an intermediate layer, i.e., contacting but not in direct – the chip, would meets the claimed properties; and (3) a heat conductive element having a higher-than-normal-operating-temperature melting temperature and being pre-attached to the lid with a heat treatment.

Claims 26-34 depend from rejected claim 25 and include all limitations of claim 25 thereby rendering these claims indefinite.

Claim Rejections - 35 USC § 102 and § 103

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.
>
> (e) the invention was described in
> (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or
> (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

The following is a quotation of 35 U.S.C. §103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

7. **Claims 15-19 and 23** are rejected under 35 U.S.C. 102(b) as being anticipated by Atwood et al. U.S. Patent 6,656,770 (priority is based on the corresponding Publication 2001/0026957 and rejection is based on the resulting patent and hereinafter referred to as the '770 patent).

The '770 patent discloses in Figures 1-5 and respective portions of the specification a system for dissipating heat from a semiconductor device as claimed.

Referring to **claim 15**, the '770 patent discloses a system for dissipating heat from a semiconductor device, comprising:

a thermally conductive lid (integral cap 20, heat exchange 14, and fin 17), comprising at least one cavity (16) corresponding to at least one die (12) mounted on a substrate (10); and

a conductive layer (solder composition 18) deposited in the at least one cavity and having a melting point greater than the maximum operating temperature of the semiconductor device (column 7, lines 50-60: "the liquidus temperature is greater than or equal to the IC chip's highest operating temperature"), the conductive layer operable to substantially fill a space between the at least one cavity and the at least one die when the lid is coupled to the substrate.

Referring to **claim 16**, the '770 patent further discloses that the conductive layer (18) is further operable to assume a liquid state ("reflow") when heated, the liquid state operable to distribute the conductive layer within the space between the at least one cavity and the at least one die when the lid is coupled to the substrate (column 11, lines 24-45).

Referring to **claims 17-19**, the '770 patent further discloses that the conductive layer is eutectic solder, is a lead-tin solder, or is an indium-based solder (column 8, lines 19-35: "Diverse solder compositions that comply with the thermal conductivity and phase change requirements will also satisfy the dual function of the current invention"... "[T]he high-lead and eutectic Pb--Sn solders (and other Sn- and In-bearing solders) have a thermal conductivity that is an order of magnitude higher than the best thermal paste currently developed").

Referring to **claim 23**, the '770 patent further discloses that the at least one cavity comprises at least two cavities, and wherein the at least one die comprises at least two dies, each cavity corresponding to at least one of the at least two dies mounted on the substrate.

8. **Claims 25, 28-31, 33, and 35** are rejected under 35 U.S.C. 102(e) as anticipated by Sur et al. U.S. Patent 6,724,078 (the '078 patent).

The '078 patent discloses in Figures 2-4 and respective portions of the specification a system as claimed.

Referring to **claims 25 and 35**, the '078 patent discloses a system comprising:

a semiconductor die (50) having a bottom surface and a top surface;

a lid (52) with a cavity (no number) having a inner surface (no number), accommodating the semiconductor die (as is evident from Fig. 2); and

a heat conducting element (60/88, solder and organic solder) having a thermal conductivity greater than 10 W/m-°C (column 5, Table 1) adhering to the inner surface of the cavity (after the solder reflow process, step 113, Fig. 4) and conforming to the surface contour of the top surface of the chip and contacting (through layers 82, 84, 86, and see note above in the 112 rejection for the interpretation of contacting) without adhering to the top surface of the chip.

Referring to **claim 28**, the '078 patent further discloses a substrate (54) to which the lid (52) is adhered.

Referring to **claim 29**, as mentioned above, the '078 patent discloses that the heat conductive material is a solder material.

Referring to **claims 30 and 31**, column 5, Table 1, discloses that the solder material comprises lead or is substantially free of lead (when the solder material is formed of a material other than lead).

Referring to **claim 33**, although not explicitly disclosed by the '078 patent, the thermal conductivity of the heat conductive material (solder 60/88) is higher than the thermal conductivity of epoxies (as is admitted by Applicant, and as is known in the art which is disclosed by Back et al. U.S. Patent 6,756,668 (the '668 patent) in column 1, lines 52-57 and cited here only for the purpose of record keeping).

9. **Claims 25, 28-31, 33, and 35** are rejected under 35 U.S.C. 102(e) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over the '668 patent.

The properties of claims 25, 33 and 35, interpreted as condition (1) detailed above in the 112 rejection would be inherent in a convention system having a lid with a cavity and a chip sandwiching a heat conducting element, where the cavity accommodates the chip, the heat conducting element is formed of a solder material, and the solder goes through some form of reflow. In particular, the '668 patent discloses in the Background Art Section and in Fig. 2 a system comprising:

a semiconductor die (20) having a bottom surface and a top surface;

a lid (40) with a cavity (48) having a inner surface (42), accommodating the semiconductor die (as is evident from Fig. 2); and

a heat conducting element ("thermal interface material", or TIM 60) having a thermal conductivity greater than 10 W/m-°C (column 1, lines 52-57) adhering to the inner surface of the cavity and conforming to the surface contour of the top surface of the chip and contacting without adhering to the top surface of the chip (see notes above for the interpretation of "adhering" and "without adhering").

As for the reflow step, it appears that all references used so far, including the instant reference as is disclosed if Fig. 6 but not explicitly in Fig. 2, teaches the reflow step as far as the heat conducting element formed of a solder material is concerned.

As for the limitations and materials of claims 28-31, they are known and available to one of ordinary skill in the art as disclosed by the references cited thus far, for example, Table 1 of the '078 patent.

Claim Rejections - 35 USC § 103

10. **Claims 20 and 21** are rejected under 35 U.S.C. §103(a) as being unpatentable over the '770 patent in view of Wilson et al. U.S. Patent Application Publication 2004/0000712 (the '712 publication).

Referring to **claim 20**, the '770 patent discloses a system for dissipating heat from a semiconductor device as claimed and as detailed above including the conductive layer 18 formed of a solder of various materials as claimed in claims 17-19 and as detailed above, but fails to disclose that the conductive layer could be a silver-filled epoxy. The '712 publication, in disclosing a conductive layer ("thermal interface") used between lid/heat sink and IC (Abstract) similarly to the present invention's and the '770 patent's, teaches that the conductive layer formed of a silver-filled epoxy (paragraph [0001]) provides long term reliability, high thermal conductivity, low thermal resistance, low shrinkage, among other advantages (paragraph [0029]). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use a silver-filled epoxy to form the '770 patent's conductive layer. One would have been motivated to make such a modification in view of the teachings by the '712

publication that the conductive layer formed of a silver-filled epoxy provides long term reliability, high thermal conductivity, low thermal resistance, and low shrinkage.

Referring to **claim 21**, the '712 publication further discloses that the conductive layer is an epoxy having a thermal conductivity greater than 10 W/m-°C (paragraph [0020]).

11. **Claim 32** is rejected under 35 U.S.C. §103(a) as being unpatentable over the '078 patent in view of the '712 publication.

The '078 patent discloses a system as claimed and as detailed above including the conductive layer 60/88 formed of a solder of various materials as claimed in claims 29-31 and as detailed above, but fails to disclose that the conductive layer could be a thermoplastic material. The '712 publication, in disclosing a conductive layer ("thermal interface") used between lid/heat sink and IC (Abstract) similarly to the present invention's and the '078 patent's, teaches that the conductive layer formed of a thermoplastic material ("thermal setting epoxy", paragraph [0001]) provides long term reliability, high thermal conductivity, low thermal resistance, low shrinkage, among other advantages (paragraph [0029]). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use a thermoplastic material to form the '078 patent's conductive layer. One would have been motivated to make such a modification in view of the teachings by the '712 publication that the conductive layer formed of a thermoplastic material provides long term reliability, high thermal conductivity, low thermal resistance, and low shrinkage.

12. **Claims 15, 17-19, and 22** are rejected under 35 U.S.C. §103(a) as being unpatentable over Sherif et al. U.S. Patent 5,623,394 (the '394 patent) in view of Rumer et al. U.S. Patent Application Publication 2003/0178730 (the '730 publication).

The '394 patent discloses in Figs. 1 and 2 a system for dissipating heat from a semiconductor device comprising a thermally conductive lid (25 or 35), comprising at least one cavity (generally defined as 27 in Fig.1 and 32 in Fig. 2) corresponding to at least one die (41...46) mounted on a substrate; and a conductive layer ("thermal compound" 51...53) deposited in the at least one cavity, the conductive layer operable to substantially fill **a** space (emphasis added) between the at least one cavity and the at least one die when the lid is coupled to the substrate. The '394 patent further discloses that the at least one cavity (27) corresponds to at least two dies (41...45) mounted on the substrate, the at least two dies operable to fit inside the at least one cavity when the lid is coupled to the substrate (in reference to **claim 22**). However, the '394 patent fails to teach that the conductive layer has a melting point greater than the maximum operating temperature of the semiconductor device. In other words, the '394 patent fails to disclose that the conductive layer, or as appropriately called thermal interface material (TIM) in the art as it is located between the thermally conductive lid and the thermally generating die for facilitating dissipating harmful thermal energy from the die to the environment, is a solder.

The '730 publication, in also disclosing a TIM, teaches that a variety of phase change materials, particularly the common solder material made up entirely of a fusible thermally conductive solder material, such as In, In/Sn, In/Ag, Sn/Ag/Cu, Sn/Bi, In/Sn/Bi and In/Zn, Sn/Ag and Sn/In/Ag (paragraph [0023]), which has a "melting point greater than the maximum

operating temperature of the semiconductor device" ("remains a solid during the normal operation of the electronic device"), paragraph [0019], and in reference to **claims 17-19**), enables application at the post-manufacturing step (paragraph [0006]: "it is necessary for the customer to obtain the thermal interface material or have it on hand so that it can be applied between the heat spreader and the semiconductor die", or application versatility for short).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form the '394 patent's system for dissipating heat from a semiconductor device using the TIM taught by the '730 publication. One would have been motivated to make such a modification in view of the teachings by the '730 publication that TIM formed of common solder materials, which meet the limitations of claims 15 and 17-19, offers application versatility.

13. **Claims 25-31 and 33-35** are rejected under 35 U.S.C. §103(a) as being unpatentable over Edwards et al. U.S. Patent 5,819,402 (the '402 patent) in view of the '730 publication.

The '402 patent discloses in Figs. 1-3 a system comprising a semiconductor die (51) having a bottom surface and a top surface; a lid ("cap" 50) with a cavity (no number) having a inner surface (no number), accommodating the semiconductor die (as is evident from the figures); and a heat conducting element (71) adhering to the inner surface of the cavity and conforming to the surface contour of the top surface of the chip and contacting the top surface of the chip. The '402 patent further discloses that the heat conducting element contacts an edge of the die (as is evident from the figures and in reference to **claim 26**), that the lid has two or more cavities that accommodate two or more dies (**claim 27**), and that the heat conductive material in

the cavities varies in thickness (as is evident from the figures) to compensate for any variation in die-thickness (column 7, lines 40-45, in reference to **claim 34**). The '402 patent further discloses the advantage of re-workability of the system (column 8, lines 6-10).

However, the '402 patent fails to disclose that the heat conducting element (or as appropriately called thermal interface material (TIM) in the art as it is located between the thermally conductive lid and the thermally generating die for facilitating dissipating harmful thermal energy from the die to the environment) has a thermal conductivity greater than 10 W/m-°C and further appears failing to discloses that the TIM does not adhere to the top surface of the chip (as the '402 teaches using a thermal paste for the TIM, the TIM appears to adhere to the top surface of the chip).

The '730 publication, in also disclosing a TIM between a chip and a lid having a cavity, teaches that a variety of phase change materials, particularly the common solder material made up entirely of a fusible thermally conductive solder material, such as In, In/Sn, In/Ag, Sn/Ag/Cu, Sn/Bi, In/Sn/Bi and In/Zn, Sn/Ag and Sn/In/Ag (paragraph [0023]), which is pre-attached to a surface of the cavity of the lid using a **heat treatment** (Fig. 5b and paragraph [0027]) – which meets the limitation "adhering to the inner surface of the cavity" – and which remains **solid** during the normal operation of the chip (paragraph [0019], which meets the property "contacting without adhering to the top surface of the chip", enables application at the post-manufacturing step (paragraph [0006]: "it is necessary for the customer to obtain the thermal interface material or have it on hand so that it can be applied between the heat spreader and the semiconductor die", or application versatility for short). Note that although the '730 publication does not explicitly disclose a thermal conductivity greater than 10 W/m-°C, the TIM formed of a common

solder material inherently possess the limitation. See for example, the '668 patent, column 1, lines 52-57, cited above.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form the '402 patent's system using the TIM taught by the '730 publication. One would have been motivated to make such a modification in view of the teachings by the '730 publication that TIM formed of common solder materials, which also meet the limitations of **claims 29-31**, pre-attached to the inner surface of the cavity of the lid with a heat treatment, offers application versatility, which works in concert with the stated re-workability by the '402 patent. Note also that one still has to determine the thickness of the heat conductive material in each of the cavities of the modified device to compensate for any variation in die-thickness, but that would be within the skill of one in the art at the time the invention was made.

Conclusion

14. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Tu-Tu Ho whose telephone number is (571) 272-1778. The examiner can normally be reached on 6:30 am - 5:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, DAVID NELMS can be reached on (571) 272-1787. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications

may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

TH

Tu-Tu Ho
December 02, 2004